Mi-STAR: Michigan Science Teaching and Assessment Reform

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All Lesson Plans and Handouts can be found on the **Mi-STAR Website at:**
http://mi-star.mtu.edu/GIFT2015

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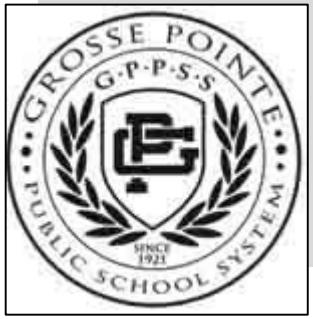
Mi-STAR
Michigan Science Teaching and Assessment Reform

Mi-STAR is…

- A partnership to reform STEM education

Michigan Tech

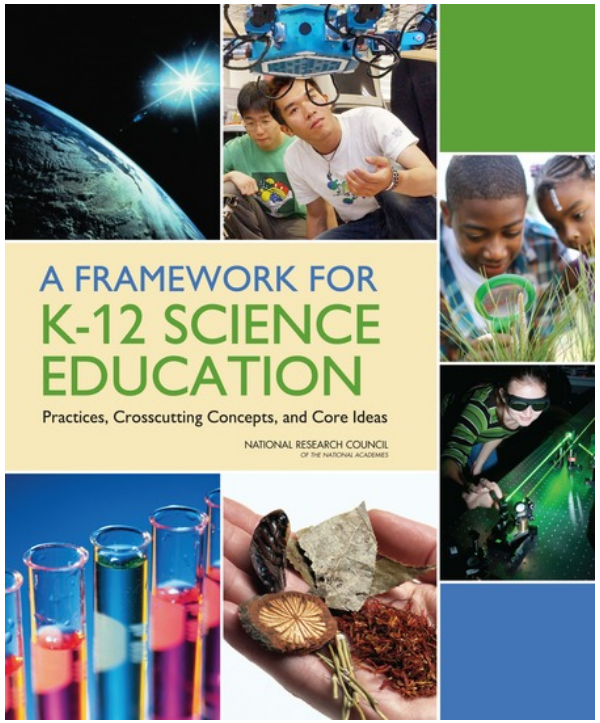


Mi-STAR is…

Motivated by a vision for the future in which science is taught and learned as an <u>integrated</u> body of knowledge that can be applied to address <u>real-world problems and phenomena</u>.

NEXT GENERATION SCIENCE STANDARDS

For States, By States

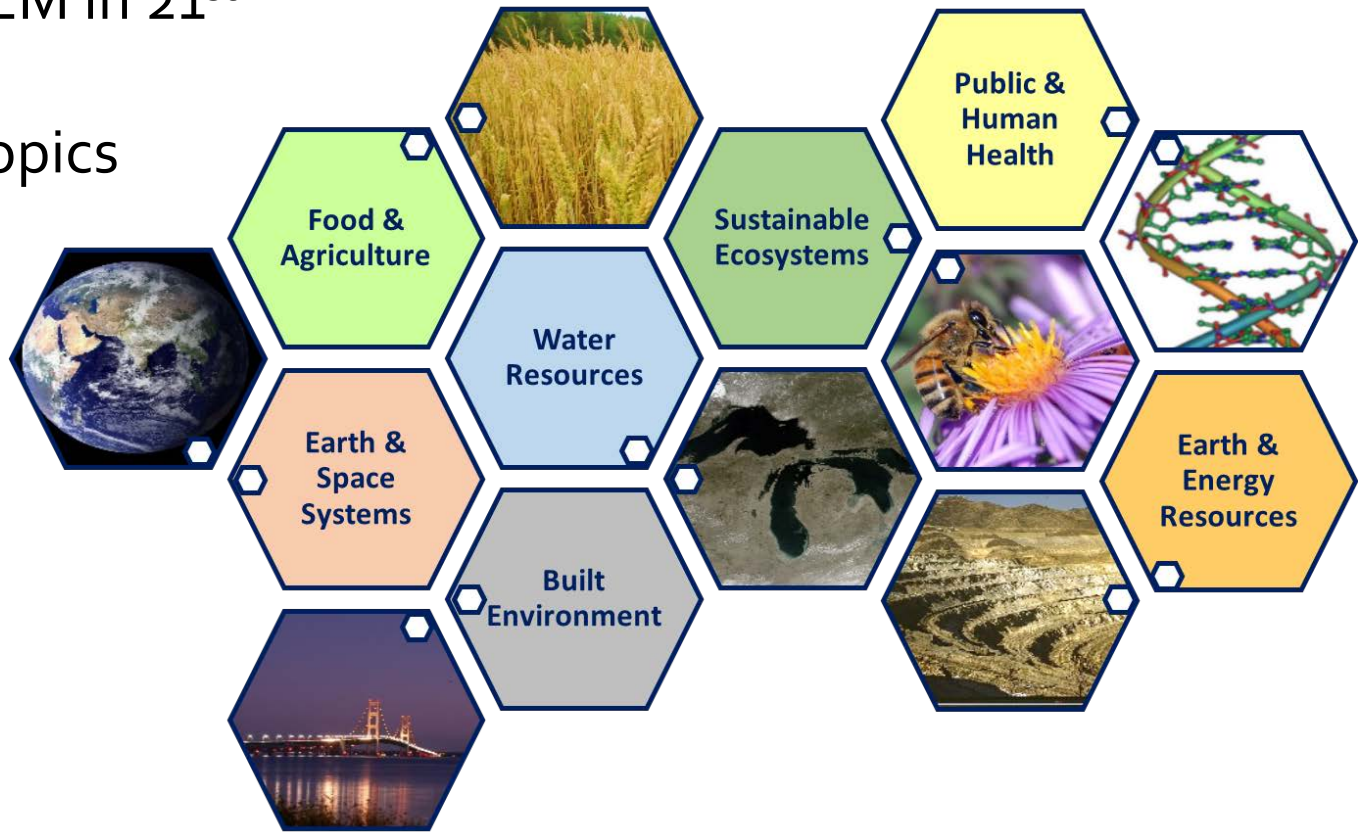


Mi-STAR is…

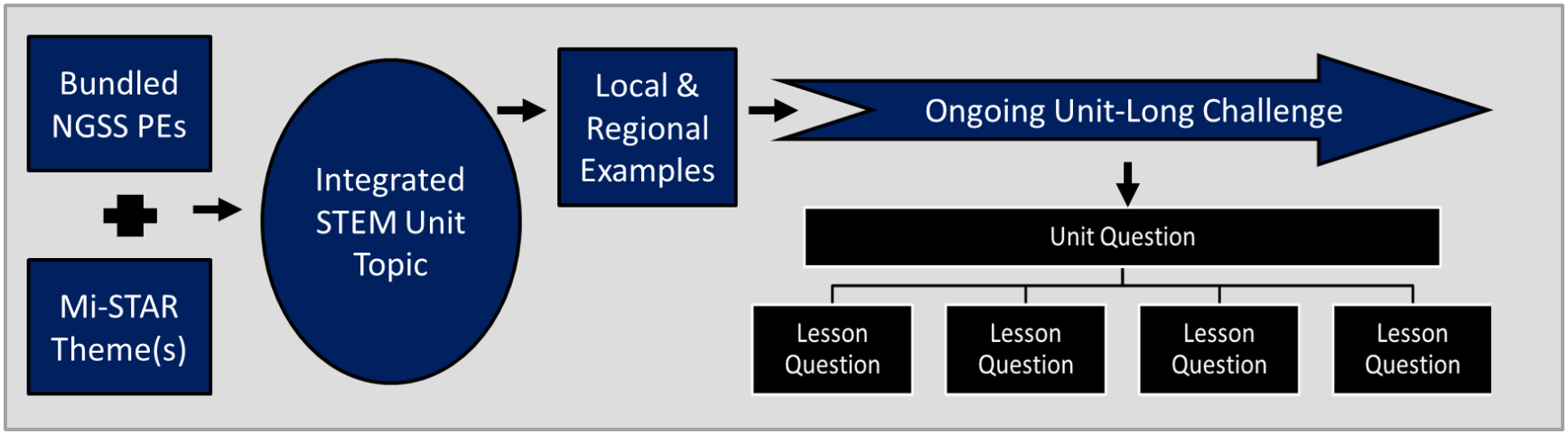
- **Developing new:**
  - Middle school curriculum and assessments
  - Teacher education programs
  - Teacher professional development opportunities

Mi-STAR Themes

- Interdisciplinary
- Apply to STEM in 21st Century
- Drive Unit Topics

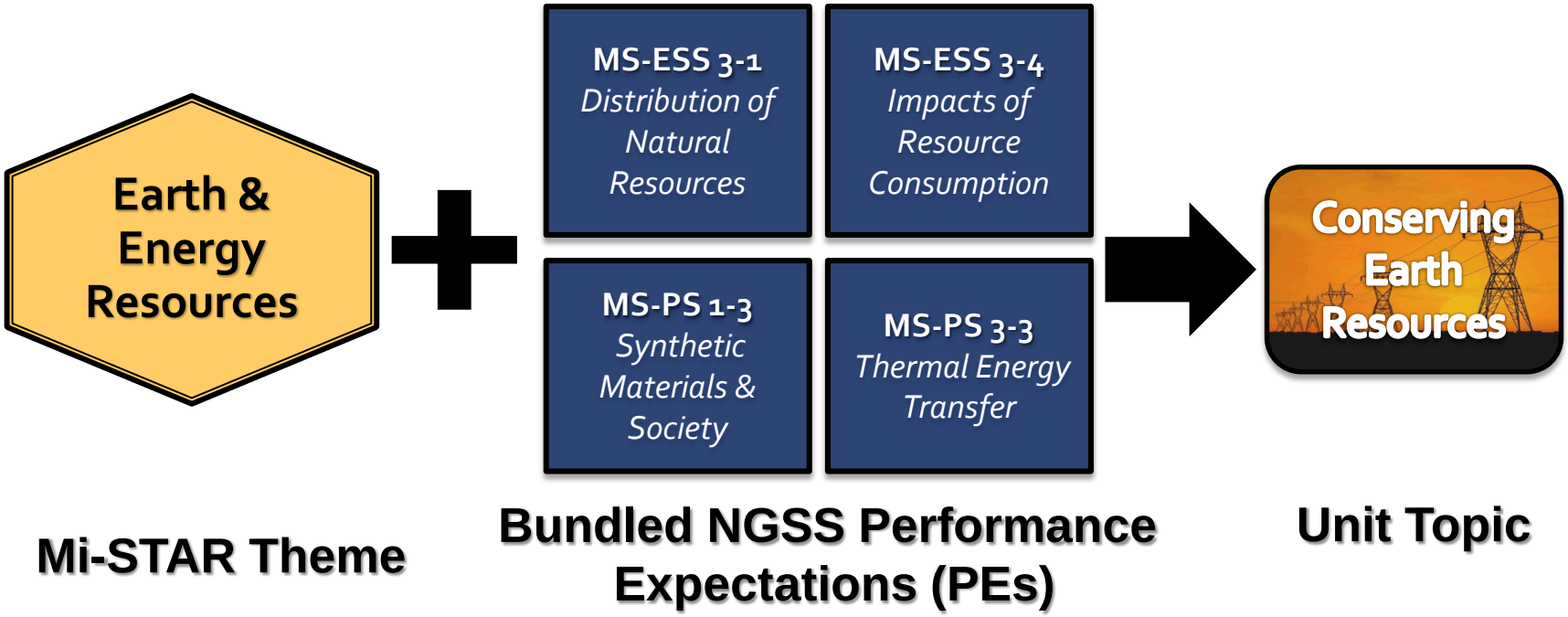


Designing a Mi-STAR Unit



Designing an Integrated Curriculum

Building Materials: How We Use Natural Resources



Earth & Energy Resources

+

MS-ESS 3-1 *Distribution of Natural Resources*

MS-ESS 3-4 *Impacts of Resource Consumption*

MS-PS 1-3 *Synthetic Materials & Society*

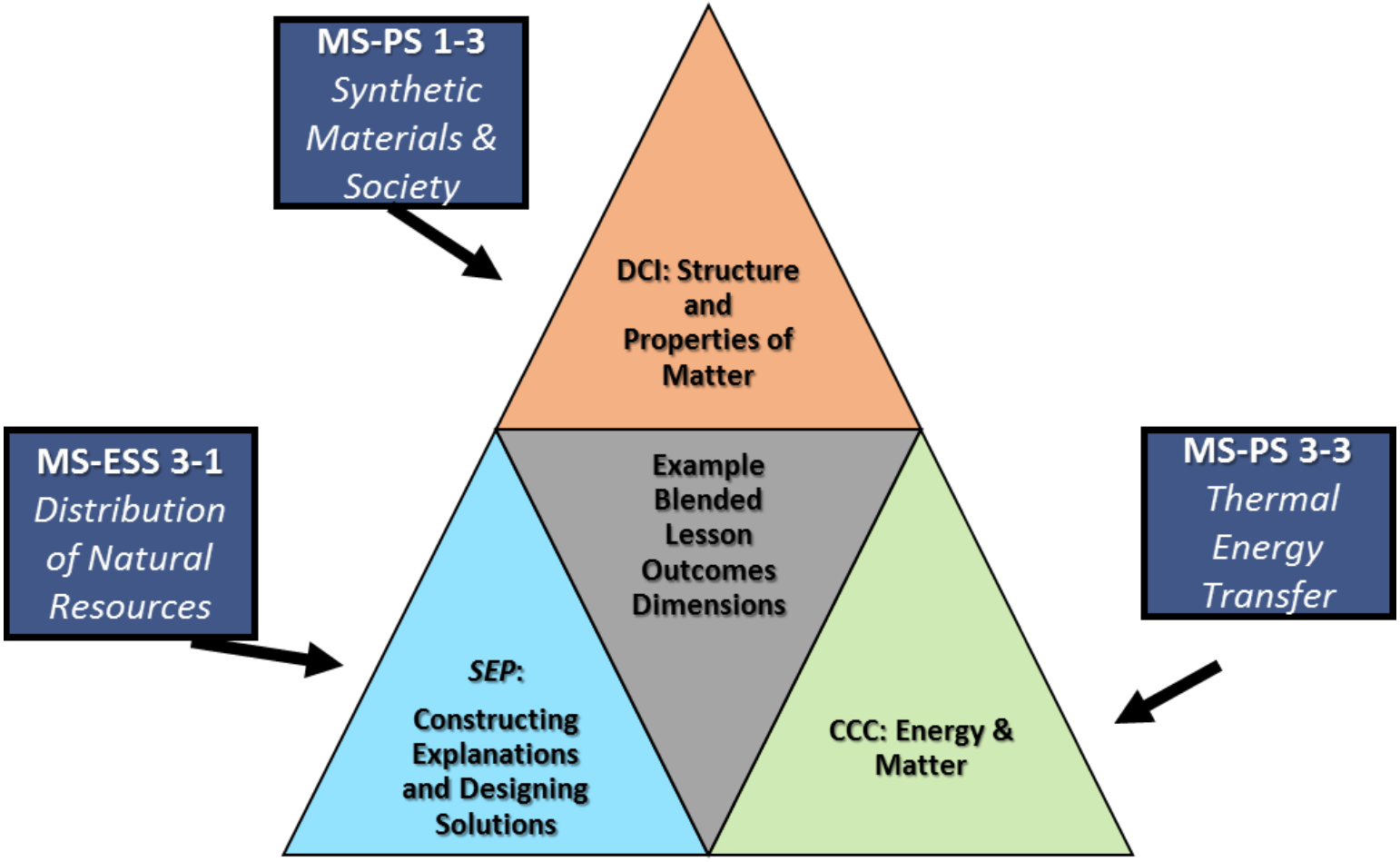
MS-PS 3-3 *Thermal Energy Transfer*

→ Conserving Earth Resources →

On-Going Unit Challenge

Select the 'best' wall insulation material for a new building in your community.

Lesson Outcomes are Blended & 3D



How do we determine which is the 'best' wall insulation?

How are the insulation's properties unique & useful?

What is insulation made from? How will it be disposed of later?

What effect does the insulation's "Life Cycle" have on Earth Systems?

Select the 'best' wall insulation material for a new building in your community.

Lesson 1: Engage in Challenge
Homes from around the world

Lesson 3: Properties of Matter

Lesson 5: Synthesizing a Synthetic Material

Lesson 8 & 9: Material Life Cycle, Impact of Life Cycle on Earth System

Lesson 2: Decision Matrix Criteria & Constraints

Lesson 4: Thermal Energy Transfer

Lesson 6 & 7: Population Growth, Distribution of Natural Resources

Lesson 10: The Final Design

Homes Around the World

Japan

USA

Newfoundland, Canada

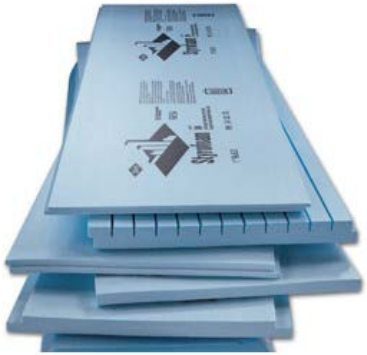
Northeast, USA

Challenge: Which is the 'best' wall insulation material for a new building in your community?

Cellulose Insulation

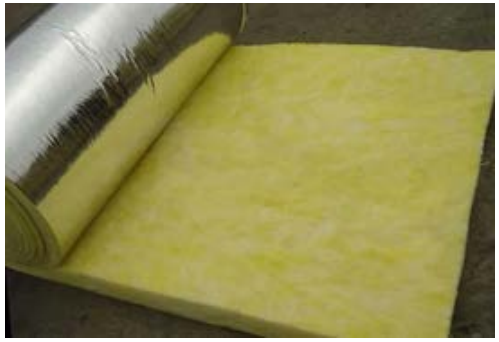
Source: http://archrecord.construction.com/products/productreports/2010/thermal/5_Quiet_Batt_Acoustic_Insulation.jpg

Foam Board Insulation



source: http://hci.frontstepsmedial.netdna-cdn.com/wp-content/uploads/2009/06/extruded-polystyrene-insulation.jpg

Rock Wool Batt Insulation

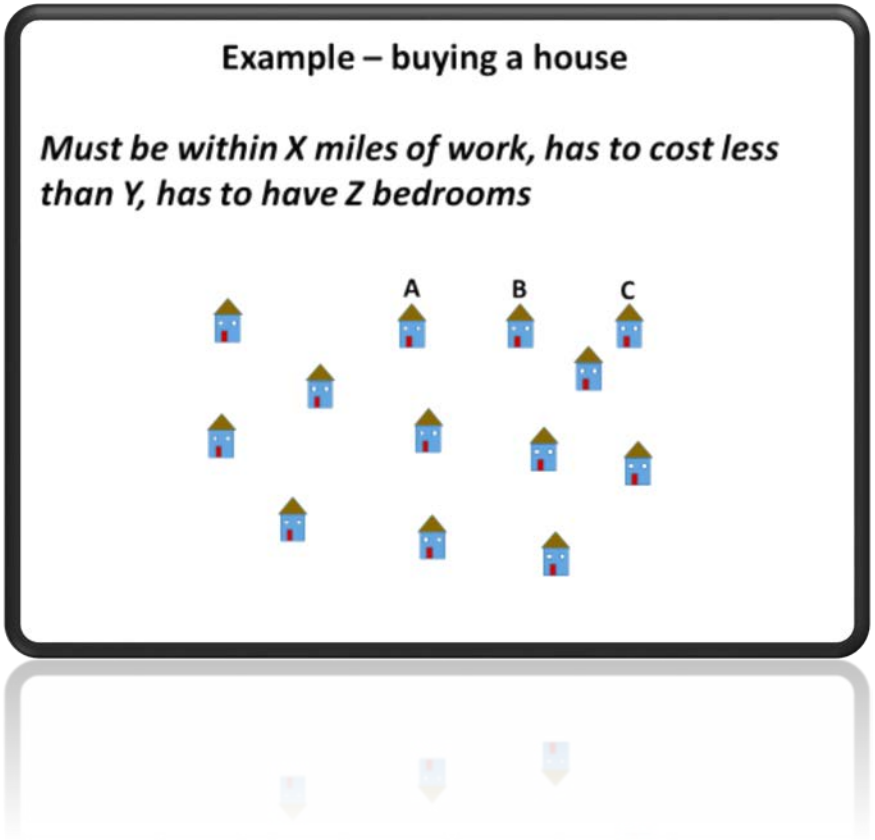


Source: http://i.ytimg.com/vi/pkwJwpEqMYo/maxresdefault.jpg

Fiberglass Batt Insulation

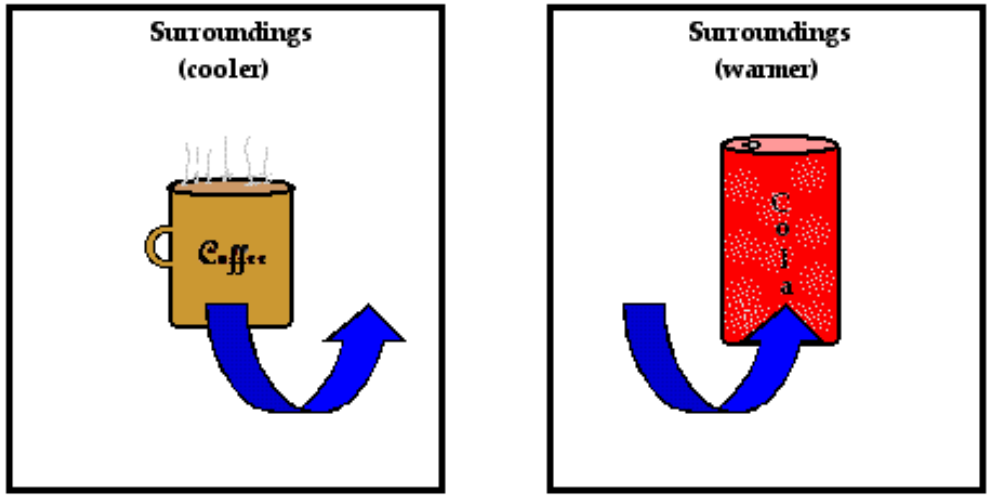
source: http://www.planningtiny.com/wp-content/uploads/2015/03/fiberglass-batt-insulation.jpg

Decision Matrix



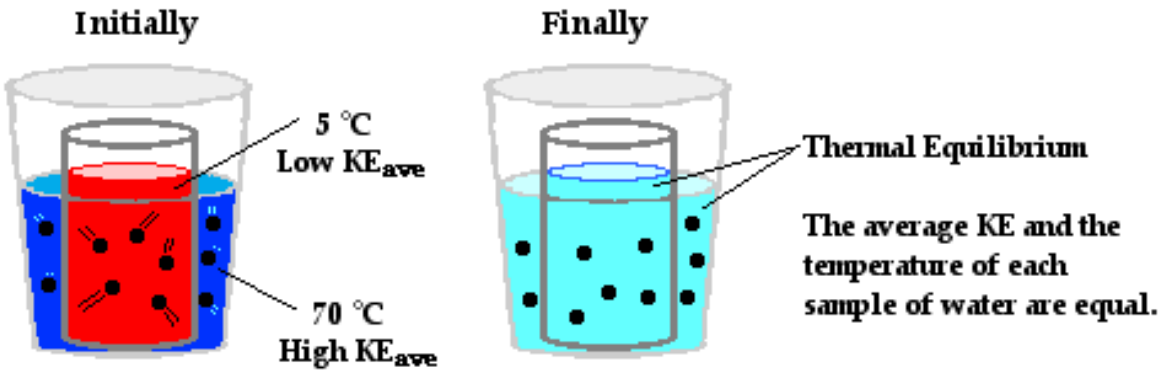
- *Specify the elements of the decision process*
- *ID important assumptions, variables involved*
- *Quantify where possible*
- *Make the decision process systematic, transparent, and understandable…*
- *ID important constraints, criteria, assign criteria values, interpret, and reflect*

Material Properties & Thermal Energy Transfer



Heat is the flow of energy from a high temperature location to a low temperature location.

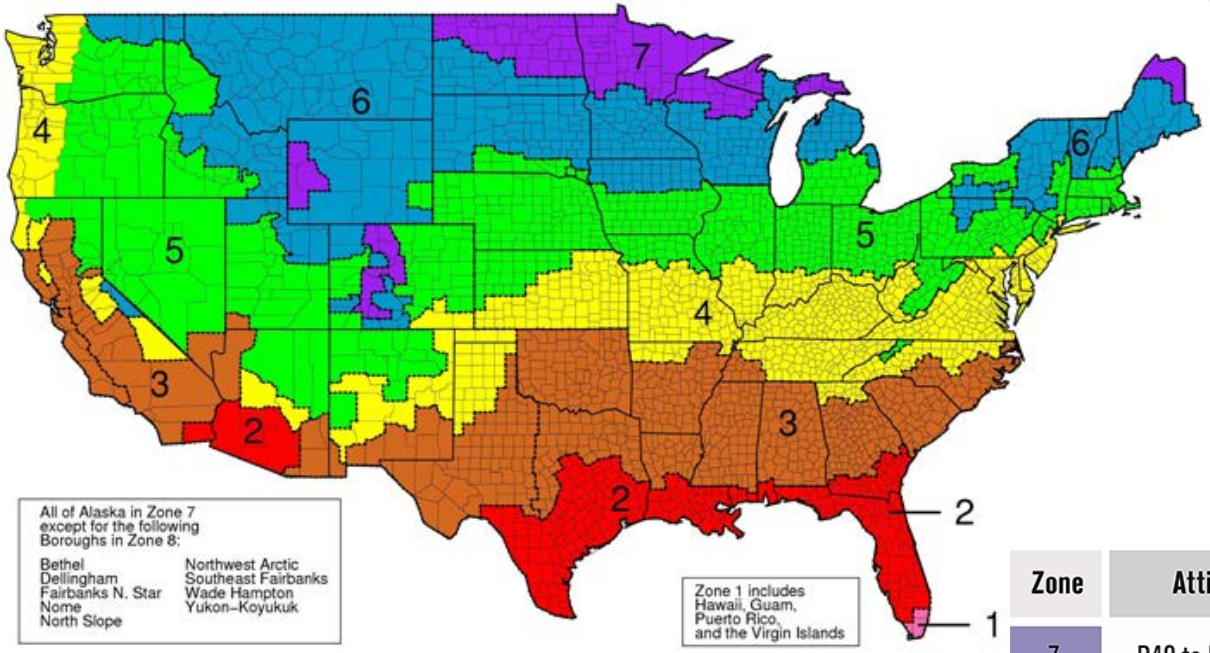
Source: http://www.physicsclassroom.com/class/thermalP/Lesson-1/What-is-Heat



Rates of Heat Transfer are Affected By:

- Temperature Difference
- Material Properties
  - Thermal Conductivity
  - Reflectivity
  - Thickness

What is *your* climate zone & recommended R-value?



Zone	Attic	2x4 Walls	2x6 Walls	Floors	Crawlspaces
7	R49 to R60	R13 to R15	R19 to R21	R25 - R30	R25 to R30
6	R49 to R60	R13 to R15	R19 to R21	R25 - R30	R25 to R30
5	R49 to R60	R13 to R15	R19 to R21	R25 - R30	R25 to R30
4	R38 to R60	R13 to R15	R19 to R21	R25 - R30	R25 to R30
3	R30 to R60	R13 to R15	R19 to R21	R25	R19 to R25
2	R30 to R60	R13 to R15	R19 to R21	R13	R13 to R19
1	R30 to R49	R13 to R15	R19 to R21	R13	R13

Image sources:
https://www.energystar.gov/ia/home_improvement/home_sealing/images/insulation_map.jpg and
http://www.lowes.com/projects/images/buying-guides/Building-Supplies/insulation-bg-rvalues.jpg

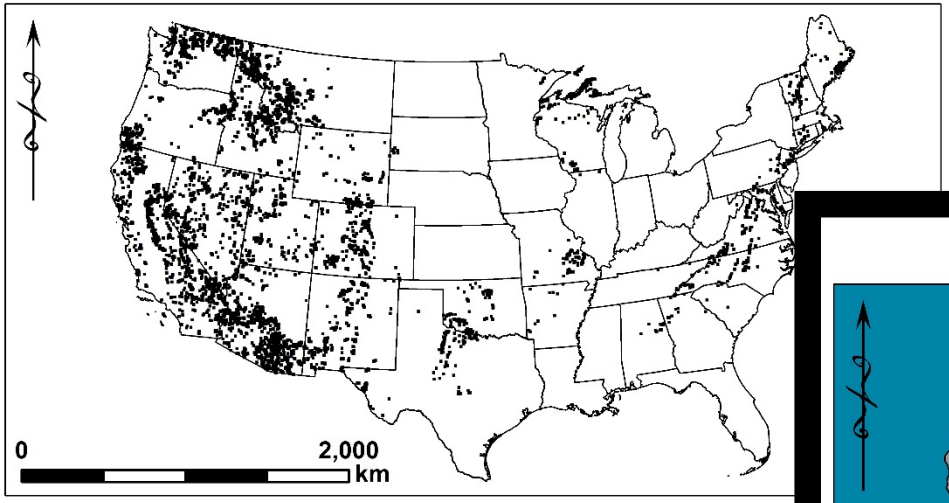
Material R-Value Per Inch

Material	R / inch
Vermiculite	2.3
Cellulose	3.1 - 3.7
Glass Fiber Batts	3.2 - 3.6
Rock Wool Batts	3.5
Polystyrene	3.6 - 5.0
Urethane Foam	5.5 - 6.0

R-Values	11	13	19	22	30
Loose Fill					
Fiberglass	5.0″	5.5″	8.5″	8.5″	13.0″
Rock Wood	3.5″	4.0″	6.0″	6.0″	9.0″
Cellulose	3.0″	3.5″	5.5″	5.5″	8.5″
Vermiculite	5.0″	6.0″	10.5″	10.5″	14.5″
Batts/Blankets					
Fiberglass	3.5″	4.0″	7.0″	7.0″	8.5″
Rock Wool	3.5″	4.0″	7.0″	7.0″	8.5″
Riged Board					
Polystyrene	3.0″	3.5″	3.5″	5.5″	7.5″
Urethane	2.0″	2.0″	2.0″	3.5″	5.0″
Fiberglass	3.0″	3.5″	3.5″	5.5″	7.5″

Uneven Distribution of Natural Resources

Copper Deposits in the United States



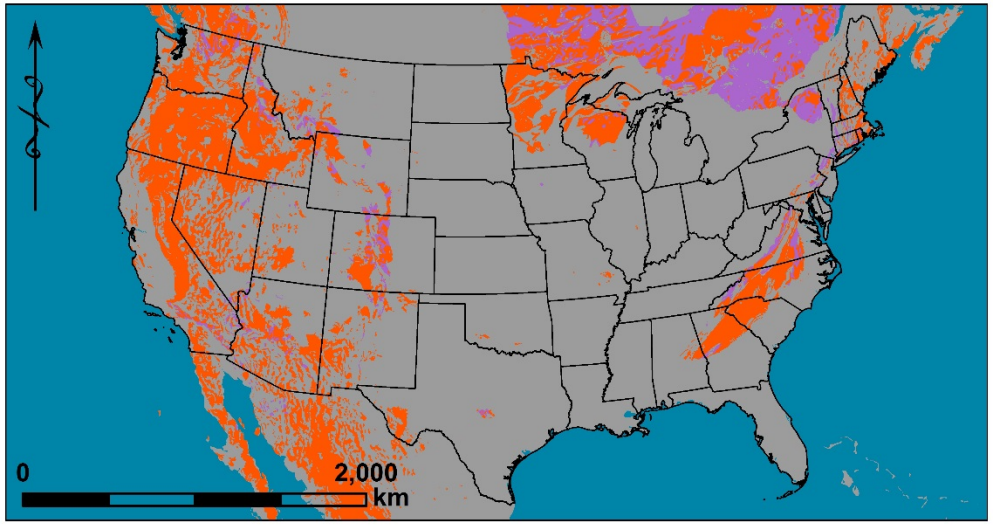
Data sources:

Copper Deposits: USGS Mineral Resources On-Line Spatial Data. Geographic information system shapefiles. [http://mrdata.usgs.gov/mrds/]

State boundaries: US Census Cartographic Boundary Shapefiles (1:500,000) 2014. [https://www.census.gov/geo/maps-data/data/cbf/cbf_state.html]

Prepared by Rudiger Escobar Wolf, Michigan Tech University, August 2015.

Major rock types in the United States



Rock type

- Sedimentary
- Igneous
- Metamorphic

Data sources:

Rock types: Garrity, C.P., and Soller, D.R., 2009, Database of the Geologic Map of North America; adapted from the map by J.C. Reed, Jr. and others (2005): U.S. Geological Survey Data Series 424 [http://pubs.usgs.gov/ds/424/].

State boundaries: US Census Cartographic Boundary Shapefiles (1:500,000) 2014. [https://www.census.gov/geo/maps-data/data/cbf/cbf_state.html]

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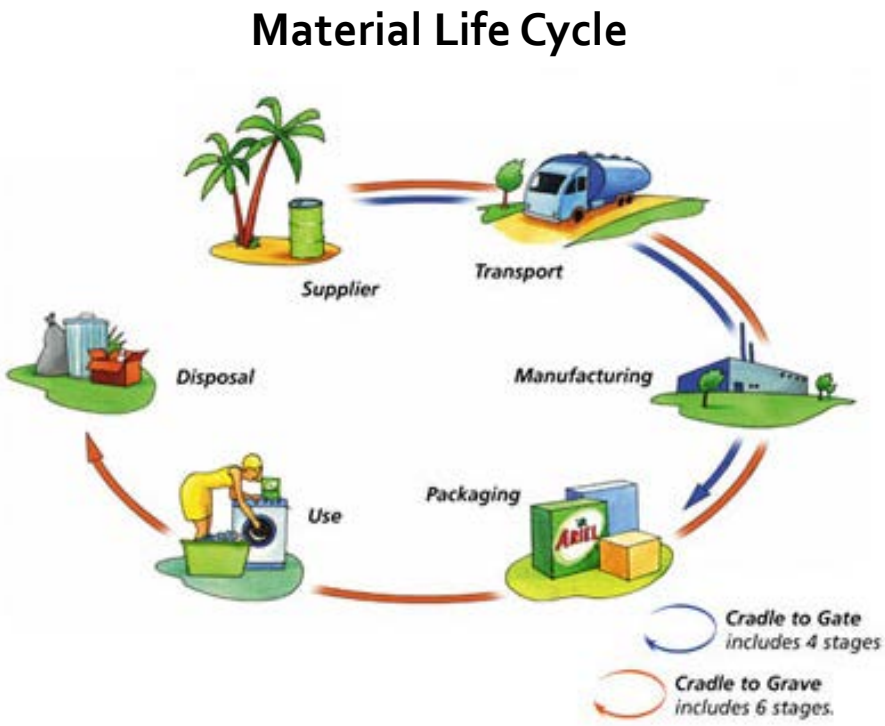
Life-Cycle Assessment

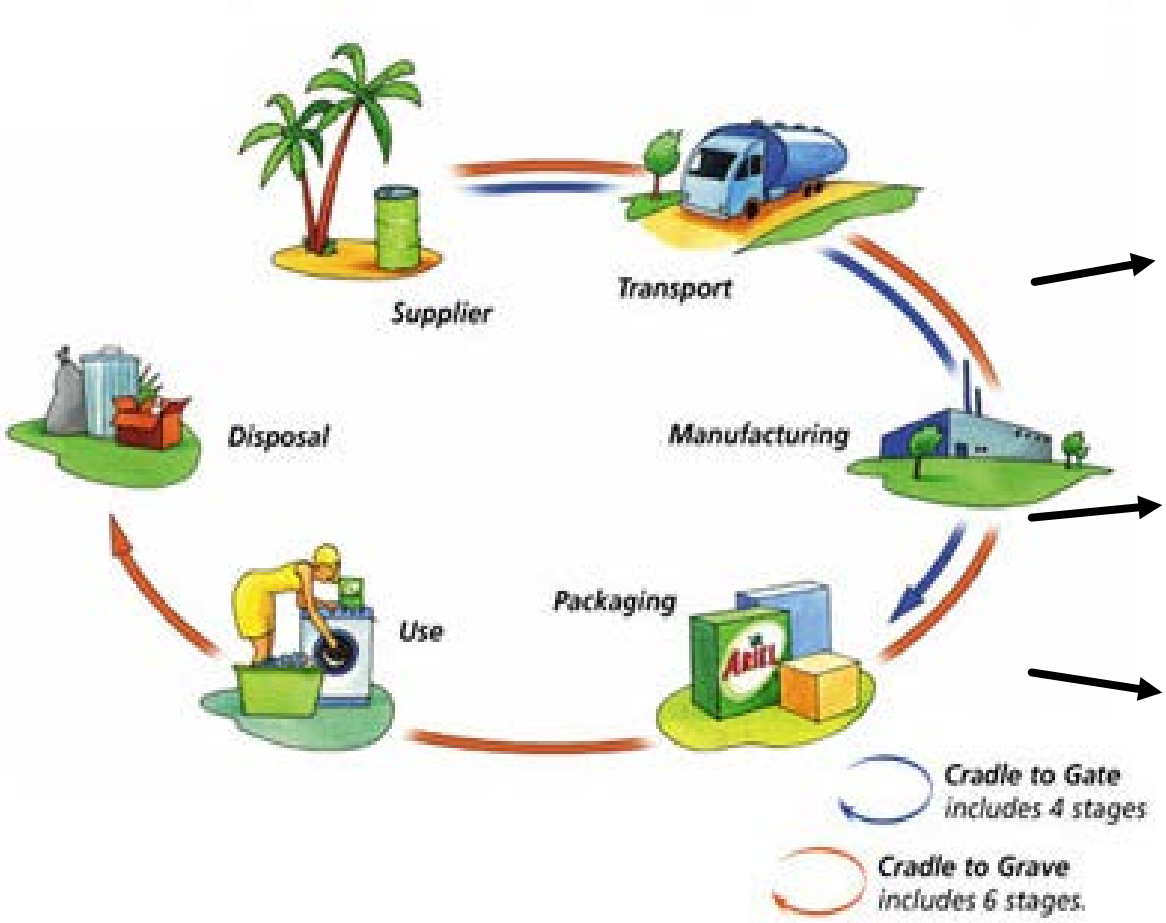


www.scienceinthebox.com.de

- Method of tracking, measuring environmental impacts
- Increasing importance in all industries
  - - e.g., LEED, U.S. Green Building Council
- Reduce environmental impacts of current products / systems
- Improve design of new products / systems

Life-Cycle Assessment

- **All life-cycle stages can have impacts!**



Standard Procedures

Defining System is Key!

List of Inputs, Outputs
(build on prior data)

Impact Assessment
(standard methods)

Interpretation
'hot spots' in life cycle?
choose alternatives?

Final Decisions:

Which is the 'best' wall insulation?

DECISION CRITERIA	Objective Weight %	Fiberglass		Cellulose		Foam Board		Rock Wool	
		Rating	Score	Rating	Score	Rating	Score	Rating	Score
Material Properties									
Insulating Value									
Local Availability									
Renewability									
Chemicals & Additives Required									
Energy Consumed									
Recycled Content									
Air Pollution Emitted									
Total	100%								

Objective Weight% x Rating = Score

Thank you!

Mi-STAR: A model for integrated science reform

Michigan Tech

For further information visit the Mi-STAR website at http://mi-star.mtu.edu

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